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3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	MARCONI COMMUNICATIONS LIMITED P O BOX 53 NEW CENTURY PARK COVENTRY CV3 1HJ
	Patents ADP number *(if you know it)* If the applicant is a corporate body, give the country/state of its incorporation	ENGLAND 7519200001
4.	Title of the invention	NETWORK INTERCONNECTIONS
5.	Name of your agent *(if you have one)*	H A BRANFIELD
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	GEC PATENT DEPARTMENT WATERHOUSE LANE CHELMSFORD ESSEX CM1 2QX
	Patents ADP number *(if you know it)*	7094592001
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8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body* *See note (d)*	YES

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Description	15
Claim(s)	3
Abstract	—
Drawing(s)	21 + 21

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Priority documents	—
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Statement of inventorship and right to grant of a patent (Patents Form 7/77)	—
Request for preliminary examination and search (Patents Form 9/77)	1
Request for substantive examination (Patents Form 10/77)	1
Any other documents (Please specify)	

11. I/We request the grant of a patent on the basis of this application.

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H A BRANFIELD

Date
12.05.99

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NETWORK INTERCONNECTIONS

The interconnection of nodes within a network can be limited by a number of physical aspects, which can totally prevent some topologies, or make other topologies comparatively inefficient. Multistage networks are a way of building large networks from nodes of limited capability, but restricting the number of stages traversed to a minimum, is a very desirable goal.

It is desirable in practical multistage networks, particularly where the nodes are on different geographical sites, to restrict the total number of interconnection routes to any node.

Fully Interconnected 3-stage networks have a large CHOICE of ROUTEs which can cause considerable searching difficulties. A fully interconnected network is shown in Figure 1. where 7 Area Nodes are fully connected via 7 STAR Nodes. Partially Interconnected Networks which have a smaller, but fixed, choice in the number of routes between all the nodes that wish to be interconnected, are of considerable benefit for the implementation of practically dimensioned networks.

According to the present invention there is provided a partially interconnected network comprising a plurality of Allocated Nodes, which Allocated Nodes are each allocated to one of a number of AREAs, and further comprising a plurality of STAR Nodes (STARs), and also comprising point to point interconnections between the Allocated Nodes and the STAR Nodes, where the number of AREAs with Allocated Nodes connected to an individual STAR forms the number of ROUTEs from an individual STAR, the Allocated Nodes of a first of the AREAs being connected to a set comprising some, but not all, of the STAR Nodes, and wherein further of the AREAs are similarly connected to further sets each comprising STAR

Nodes and where there is at least one connection choice (CHOICE) between any two Allocated Nodes in different AREAs and where a connection route comprises two point to point interconnections connected in series by a STAR Node.

The present invention will now be described by way of example, with reference to the accompanying drawings, in which,

Figure 1 shows a schematic diagram of a fully connected network;

Figure 2 shows a schematic diagram of a fully meshed network;

Figure 3 shows a schematic diagram where one AREA is connected to 5 STAR Trunks;

Figure 4 shows a schematic diagram where STAR Trunks are each connected to 5 AREAs;

Figure 5 shows the connections in the diagram of Figure 4 in tabular form;

Figure 6 shows the contiguous sequences from Figure 4;

Figure 7 shows the connections of a counter rotational version of Figure 5 in tabular form;

Figure 8 shows the example of Figure 5 where the AREAs and STARs have been reordered;

Figure 9 shows a schematic diagram using a single SDH-AREA Crossconnect;

Figure 10 shows a schematic diagram using a pair of SDH-AREA Crossconnect;

Figure 11 lists examples of Rotational Patterns;

Figure 12 lists examples of Other Patterns;

Figure 13 shows an example of a twin choice pattern;

Figure 14 shows an example of a triple choice pattern;

Figure 15 shows an example of a quad choice pattern;

Figure 16 shows an example of a quin choice pattern;

Figure 17 shows a network using SDH interfaces on DSS mk2;

Figure 18 shows an example of a Multi-Rotational Pattern

Figure 19 shows an Asymmetric Twin CHOICE network.

Figure 20 shows a Symmetrical Twin CHOICE Pattern

Figure 21 shows a re-ordered example of a Symmetrical Twin CHOICE Pattern

Figure 22 shows an Equally Grouped Asymmetric single CHOICE Pattern

Figure 23 shows an Unequally Grouped Asymmetric single CHOICE Pattern

Figure 24 shows an Asymmetric Twin CHOICE network for 10 AREAs.

Figure 25 shows an Asymmetric Triple CHOICE network for 8 AREAs.

Figure 26 shows an Asymmetric Twin CHOICE network

Figure 27 shows a Single CHOICE Asymmetric Pattern using 3-pointed STARs

Figure 28 shows a Single CHOICE Asymmetric Pattern based on an odd square

Figure 29 shows a 30 AREA Single CHOICE network using 5-pointed STARs

Figure 30 shows a 56 AREA Single CHOICE network using 7-pointed STARs

Figure 31 shows a 15 AREA Single CHOICE network using 3-pointed STARs

Figure 32 shows a 21 AREA Single CHOICE network using 3-pointed STARs

Figure 33 shows a 27 AREA Single CHOICE network using 3-pointed STARs

Figure 1 gives an example of a fully Connected 3 Stage Network where 7 AREAs (Nodes) are fully interconnected via 7 STARs Nodes giving 7 routes between each pair of AREAs (Nodes), whereas Figure 2 shows a fully meshed network. The disadvantage of a fully meshed network is that as the number of AREA Nodes increases so the size of the routes between the AREA Nodes has to be reduced, if the switches at the AREA Nodes are already at maximum capacity.

In order to utilise regular interconnect patterns in networks with a variable number of local nodes (e.g. local exchanges), it is necessary to group the local nodes into areas. AREAs are not intended, in general, to represent geographical areas, though they may do so.

A number of regular interconnection patterns will now be shown where the number of STAR nodes (e.g. trunk exchanges) equals the number of AREAs (or an integral multiple of the number of AREAs). Further interconnection patterns will be shown where the number of STAR nodes does not equal the number of AREAs (or an integral multiple of the number of AREAs).

It is stressed that the number of circuits (or capacity) handled by a route will depend on the physical capacity of the transmission. The key aspect of the present invention is which nodes have routes between them, the capacity of each route being a separate dimensioning issue and in practical networks the routes would not all have the same capacity/number of circuits.

A simple 3-stage network could have all the local nodes connected to all the STAR (Trunk) Nodes. For a Partially Interconnected Network; all the Local Nodes in an area are connected to a fixed number of STAR Nodes, but not to all the STAR Nodes.

Partially Interconnected Networks will have a fixed choice in the number of connection routes between a local node in one area and a local node in another area, This fixed number will be called CHOICE, as where there is more than one connection route a choice can be made between them. Where the CHOICE is one this is described as a Single Connectivity Pattern,

where the CHOICE is two a Twin connectivity Pattern, etc.

For the purpose of understanding the patterns described it is easier to concentrate on the relationships between AREAs and the STARs

The object of the present invention is to determine regular Partial Interconnection Networks with Single, Twin, etc. connectivity patterns. For there to be a possibility of this to happen the following relationship needs to be valid:

(AREAs)x(AREAs - 1) x (CHOICES) = (STARs) x (ROUTEs) x (ROUTEs - 1)

where

AREAs	is the number of AREAs
CHOICEs	is the fixed number of connection routes
STARs	is the number of STAR Nodes
ROUTEs	is the number of AREAs to which a STAR has connections.

This formula is only valid for integer values of AREAs, CHOICEs, STARs and ROUTEs. The object of the formula is to match the total number of single routes between the areas (AREAs) x (AREAs - 1) with the number of routes provided by each STAR Node (ROUTEs) x (ROUTEs - 1) multiplied by the number of STARs. For multiple choice arrangements the STARs must provide 2, 3, etc. times the number of routes.

Just because there is a possibility of finding a fixed choice connectivity pattern does not mean that any such pattern exists.

The further relationship also needs to be valid:

(STARs)x(ROUTEs)/(AREAs) = a positive integer

This further relationship is of importance when the number of STARs is not equal to the Number of AREAs

In the arrangements shown below the AREAs and STAR NODEs are cyclically numbered for ease of explanation, but this identification is not an essential feature of the invention and other identifiers may be used or none at all.

Consider 21 AREAs and 21 STARs as shown in Figures 3, 4 and 5;

AREA 1 is connected to STARs	1,	6,	8,	18,	21,
AREA 2 is connected to STARs	2,	7,	9,	19,	1
AREA 3 is connected to STARs	3,	8,	10,	20,	2 etc.

To traverse from AREA 1 to AREA 2 there is only one route and that is via STAR 1.

To traverse to other areas

1 to 3 via STAR 8	1 to 4 via STAR 21	1 to 5 via STAR 1
1 to 6 via STAR 6	1 to 7 via STAR 6	1 to 8 via STAR 8

1 to 9 via STAR 8	1 to 10 via STAR 6	1 to 11 via STAR 18
1 to 12 via STAR 8	1 to 13 via STAR 18	1 to 14 via STAR 21
1 to 15 via STAR 1	1 to 16 via STAR 21	1 to 17 via STAR 1
1 to 18 via STAR 18	1 to 19 via STAR 18	1 to 20 Via STAR 6
1 to 21 via STAR 21		

For the pattern shown in Figure 4 to have the single connectivity property listed above, the connections to a STAR from an AREA must have the property of a set forming a contiguous sequence. This is where all the modulo differences of the numbers allocated to the cyclically numbered STAR Nodes (connected to an AREA) selected in pairs form a contiguous sequence from one to the number of cyclically numbered AREAS less one.

For this example which uses 21 AREAS with connections to 5 STARs (namely 1, 6, 8, 18 and 21) out of a Constellation of 21 STARs (Figure 6) there are 10 pairings of STARs and the modulo differences are as follows:

STAR Pairings		Modulo Differences		
		SPANNING DIFFERENCES		
1	21	1	&	20
6	8	2	&	19
18	21	3	&	18
1	18	4	&	17
1	6	5	&	16
6	21	6	&	15
1	8	7	&	14

8	21	8	&	13
6	18	9	&	12
8	18	10	&	11

For each such fixed choice rotational connectivity pattern there is a similar, but counter-rotational version of the pattern of Figure 5, which is shown in Figure 7.

An arrangement of STARs (e.g. 21 STARs) is being called a Constellation. For a network that requires twice the throughput then a second constellation could be connected in parallel to the first constellation. In such a case by using a fixed choice counter rotational connectivity pattern, then a significant advantage results. It not only adds redundancy, but also if a STAR should fail then the traffic formally carried by the failed STAR could be shared between 4 STARs in the other 21 STAR Constellation.

The use of regular rotational patterns which provide contiguous sequences is a convenient way to analyse and deduce Partially Interconnected Networks which have a fixed choice connectivity for example single connectivity, twin connectivity, etc. However, once the connectivity pattern has been established the pattern can be transformed by reordering the AREAs and by reordering the STAR Nodes, whilst still retaining an equal number of connection routes between any two Local nodes in different areas. A connection route comprises two point to point interconnection means connected in series by a STAR Node, see Figure 8. The AREAs and STAR Nodes can also be renumbered. The original AREA and STAR numbering used on Figure 5 is shown on the bottom and right respectively on Figure 8.

The use of Partially Interconnected Networks is appropriate to telecommunications networks which have local exchanges and trunk exchanges. The local exchanges are grouped into areas and connected to a set of STAR Trunks. In order to simplify transmission connections the use of an AREA Crossconnect can be considered. An Synchronous Digital Hierarchy (SDH) Crossconnect, or a pair of SDH Crossconnects for redundancy, Figures 9 and 10 respectively, can be employed. Two Synchronous Transport Module (STM)-1s are connected to a local, a pair of locals or 3 locals one being taken to each of the two Crossconnects making an AREA Crossconnect. A first set of STM-1s is taken to the STAR Trunks (normally one per star) from a Replica A. A second set of STM-1s is taken to the STAR Trunks (normally one per STAR) from Replica B.

The use of Partially Interconnected Networks is also appropriate to packet, router, transmission and any large network where the sizes of switches are limited, or where redundant architectures are required.

In data networks running with the Internet Protocol (IP) the AREA Crossconnect could be an IP router, or a pair of IP routers for redundancy, or an ATM switch, or a pair of ATM switches for redundancy.

Figure 11 lists some examples of the rotational patterns where the number of STARs equals the number of AREAs or a Multiple of the number of AREAs. The pattern examples detail the AREAs connected to STAR 1 for rotational and multi-rotational patterns.

Figure 12 lists some examples of non- rotational patterns.

Figure 11 and Figure 12 also list patterns that can be formed by taking a known constellation using 7-pointed STARs and replacing all (or some) of the 7-pointed STARs with 7 three-pointed STARs. They also lists patterns that can be formed by taking a known constellation using 4-pointed STARs and replacing all (or some) of the 4-pointed STARs with 4 three-pointed STARs. The final pattern having twice the number of CHOICEs. Similarly 7-pointed STARs can be replaced by 7 four-pointed STARs. Such transforms considerably increase the traffic carrying capacity of a network.

Another way of increasing capacity is by adding another complete constellation, however if only one or some STARs are overloaded then by just placing a further STAR in parallel with an existing STAR then this will also increase the capacity of the overloaded part of the network. Although the network may have extra choices on some routes, this is still a very practical network. It is possible to limit the choices in the routing tables to restrict the choices whilst still retaining the increased load capacity.

Examples of Twin (Figure 13), Triple (Figure 14), Quad (Figure 15) and Quin (Figure 16) choice rotational connectivity patterns.are shown on the indicated figures. The use of computer programs to look for valid contiguous spanning sequences can simplify the examination process.

Digital Switching Subsystem (DSS) mark 2 terminates STM-1 or part STM-1 as shown in Figure 17. DSS mark 2 is a subsystem of System X, which is a telecommunication system marketed by Marconi Communications Limited. G.703 is a telecommunication interface

recommendation by the International Telecommunications Union Telecommunications (ITU-T). The line shelf used can also terminate STM-4s. A STAR Trunk receives 6 x STM-1s from the 5 AREAs. DSS mark 2 can accept 30 or 31 STM-1s. The description is based on dedicated STM-1 transmission but Plesiochronous Digital Hierarchy (PDH) and STM-4s can be used where appropriate and all transport could also be patched through the general 2 Mbit/s network.

It is possible to have Partially Interconnected Networks where the number of STARs is a integer multiple of the number of AREAs. Figure 18 shows an example of this where two different rotational arrangements are used to create a 3 choice pattern. Other examples are listed in figure 11 for using 2, 3, 4 and 5 rotational arrangements to create both single and twin choice patterns.

It is also possible to have Partially Interconnected Networks where the number of STARs is not an integer multiple of the number of STARs, although (STARs)x(ROUTEs)/(AREAs) must be an integer. Figure 19 shows an Asymmetric twin choice network for 12 AREAs with 44 STARs which has 4 different patterns of 11 stars which rotate around 11 of the 12 AREAs and in which a large number of 3-pointed STARs are used.

Figure 20 has 16 AREAs and 16 STARs, but it is not formed from a single rotational pattern, but from 4 patterns. It is a twin choice network giving redundancy with each numbered STAR being connected to the same numbered AREA. Because of its symmetry it only requires a total of 40 transmission links, between the 16 AREA Nodes /(Crossconnects/Routers and the 16 STAR Nodes. However some care would be required as both paths of some redundant pairs of paths are carried by the same transmission link.

Figure 21 is a redrawn form of Figure 20, but without each numbered STAR being connected to the same numbered AREA. 48 transmission links are required between the 16 AREA Nodes /(Crossconnects/Routers and the 16 STAR Nodes, but this time no redundant pairs of paths are carried by the same transmission link.

Figures 22 and 23 are two ways, using different groupings, that single connectivity networks can be formed for 16 AREAs and 20 STARs. These are examples of where the number of STARs is neither equal to the number of STARs nor an integer multiple of the number of STARs. The figures are drawn with each numbered AREA being connected to the same numbered STAR.

Figure 24 uses 4-pointed STARs, but with 3 groups of 3 and 1 group of 1 to give a twin choice network for 10 AREAs using 15 STARs.

Figure 25 shows an Asymmetric Triple CHOICE network where the areas have been divided into two groups of 4 and 4-pointed STARs are used.

Figure 26 shows an Asymmetric Twin CHOICE network which has been drawn with each numbered STAR being connected to the same numbered AREA. Some of the following patterns are not drawn this way where it is easier to show how a range of patterns can be constructed from a basic concept.

Figures 27 and 28 both have 9 AREAs and 12 STARs, but the two figures have been drawn in slightly different ways.

Figure 28 is the first of an infinite series of patterns: where the STARs have an odd number of ROUTEs {ROUTEs equals an odd integer}; where the number of AREAs is the square of the number of ROUTEs on the STAR i.e.{AREAs = (ROUTEs)x(ROUTEs)}; and where the number of STARs = (ROUTEs)x(ROUTEs+1). In this case ROUTEs = 3, AREAs = 9, STARs = 12.

Figure 29 shows the second in the series where ROUTEs = 5, AREAs = 25, STARs = 30.

Figure 30 shows the third in the series where ROUTEs = 7, AREAs = 49, STARs = 56.

Some more in the series are listed in Figure 12.

Figure 27 is the first of an infinite series of patterns using 3-pointed stars where there are an odd number of groups and each group contains 3 areas.

Figure 31 is the second of the series with 35 off 3-pointed STARs connecting 15 AREAs. It shows the same pattern shown in three ways in order to help explain the notation used in later figures. The extra numbers to the right of the first pattern show the numbering of the STARs that would be necessary so that AREAs can be connected to a STAR with their own number.

Figure 32 is the third of the series with 70 off 3-pointed STARs connecting 21 AREAs. The first seven STARs are used to connect the AREAs together within a group with the remaining STARs used to connect 3 STARs from 7 of the groups.

Figure 33 is the fourth of the series with 117 off 3-pointed STARs connecting 21 AREAs. The first seven STARs are used to connect the AREAs together within a group with the remaining STARs used to connect 3 STARs from 9 of the groups. Figure 33 has been drawn showing how 9 STARs use the same pattern that has been shifted round by one. There are 12 such shifted patterns. The same form of pattern is used in each of the columns. In the first column the spacing of the `1□s is increased by one between each arrangement of 9 STARs whilst the □2□ is always equidistant from each of the □1□s□.

STAR TRUNKS when used to implement Partially Interconnected Networks enable far more effective trunk networks to be achieved than by the use of the present two-stage network as shown in Figure 2. Double and Triple Connectivity patterns are very appropriate to new operator networks. The technique can also be applied to Router networks and transmission (e.g. Megastream) networks.

From the foregoing it can be appreciated that the scope for arrangements conforming to the present invention is extremely large.

CLAIMS

1. A partially interconnected network comprising a plurality of Allocated Nodes, which Allocated Nodes are each allocated to one of a number of Areas, and further comprising a plurality of Star Nodes (Stars), and also comprising point to point interconnections between the Allocated Nodes and the Star Nodes, where the number of Areas with Allocated Nodes connected to an individual Star forms the number of Routes from an individual Star, the Allocated Nodes of a first of the Areas being connected to a set comprising some, but not all, of the Star Nodes, and wherein further of the Areas are similarly connected to further sets each comprising Star Nodes and where there is at least one connection choice (Choice) between any two Allocated Nodes in different Areas and where a connection route comprises two point to point interconnections connected in series by a Star Node.

2. A partially interconnected network as claimed in Claim 1, where there are an equal number (Choices) of connection routes between any two Allocated Nodes in different Areas

3.. A partially interconnected network as claimed in Claim 1 or 2, wherein : (Areas) x (Areas-1) x (Choices) = (Stars) x (Routes) x (Routes-1) and (Stars) x (Routes) / (Areas) = a positive integer.

4. A partially interconnected network as claimed in any preceding claim, where at least one of the Areas contains one Allocated Node.

5. A partially interconnected network as claimed in any preceding claim, wherein each point to point interconnection comprises a multiple circuit transmission system.

6. A partially interconnected network as claimed in any preceding claim, wherein at least one of the point to point interconnections passes through an Area cross-connect.

7. A partially interconnected network as claimed in any preceding Claim, wherein the plurality of Star Nodes equals the number of Areas or an integer multiple thereof and the number of Areas and the plurality of Star Nodes are each cyclically identified and wherein the modulo differences of the identities allocated to the cyclically identified Star Nodes in the set or sets, selected in pairs within a set, form a single contiguous sequence or multiple contiguous sequences respectively, from one to one less than the number of cyclically identified Areas, the remainder of the cyclically identified Areas being connected each to a corresponding set of cyclically identified Star Nodes which are each sequentially rotated by one from a former contiguous sequence to create a regular rotated interconnection pattern or regular rotated interconnection patterns.

8. A partially interconnected network as claimed in Claim 7 wherein in the pattern or patterns each cyclically identified Star Node is connected to a cyclically identified Area having the same cyclical identifier as the Star Node.

9. A partially interconnected network as claimed in Claim 7 or 8, wherein the rotated contiguous sequence is transformed by reordering and/or renumbering the Areas and/or reordering and/or renumbering the Star Nodes whilst retaining an equal number of connection routes between any two Allocated Nodes in different Areas, where a connection route comprises two point to point interconnections connected in series by a Star Node.

10. A partially interconnected network as claimed in Claim 7, 8 or 9, wherein a second plurality of cyclically numbered Star Nodes, equal in number to the earlier plurality of cyclically numbered Star Nodes is added to create a second interconnection pattern, where the second interconnection pattern is a counter rotating version of the pattern of connections of the earlier plurality of cyclically numbered Star Nodes.

11. A partially interconnected network as claimed in Claim 3, or any claim appendant thereto, wherein Routes is an odd integer, Areas equals Routes^2 and Stars equals Routes x (Routes + 1).

12. A partially interconnected network as claimed in Claim 3, wherein the Stars

comprise an odd integer number of Stars, each Star having three Routes connected thereto.

13. A partially interconnected network as claimed in any preceding claim, wherein Area Nodes and Star Nodes share sites and where redundant pairs of point to point interconnections of a twin choice network do not have their ends on the same pair of sites.

14. A partially interconnected network as claimed in any preceding claim, wherein one or more Areas are without any Allocated Nodes.

15. A partially interconnected network as claimed in any preceding claim, wherein the partially connected network is a telecommunications network.

16. A partially interconnected network substantially as hereinbefore described, with reference to and as illustrated in, the accompanying drawings.

17. A partially interconnected network substantially as hereinbefore described, wherein the partially connected network is a telecommunications network, with reference to and as illustrated in, the accompanying drawings

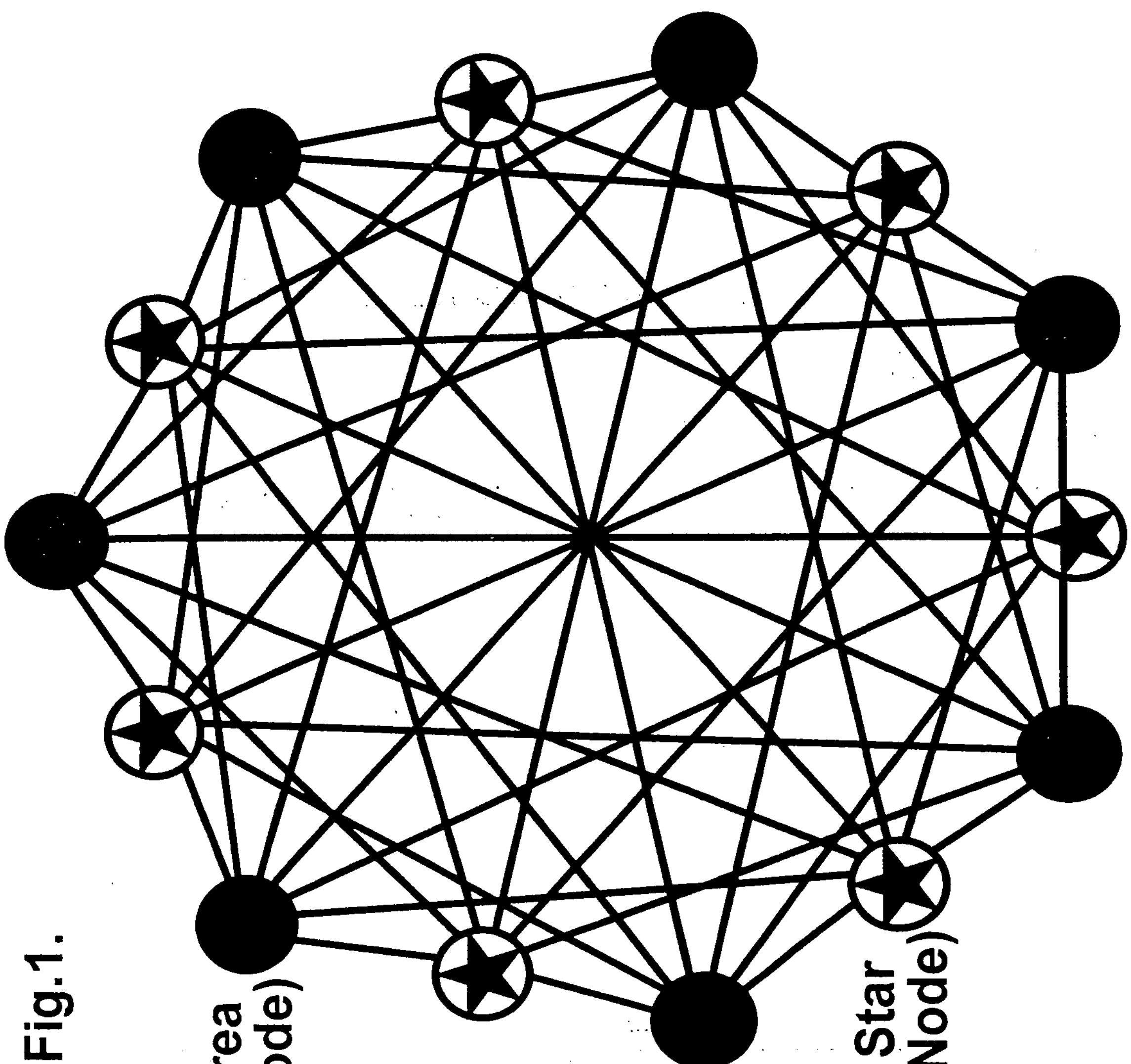

Fig.1.

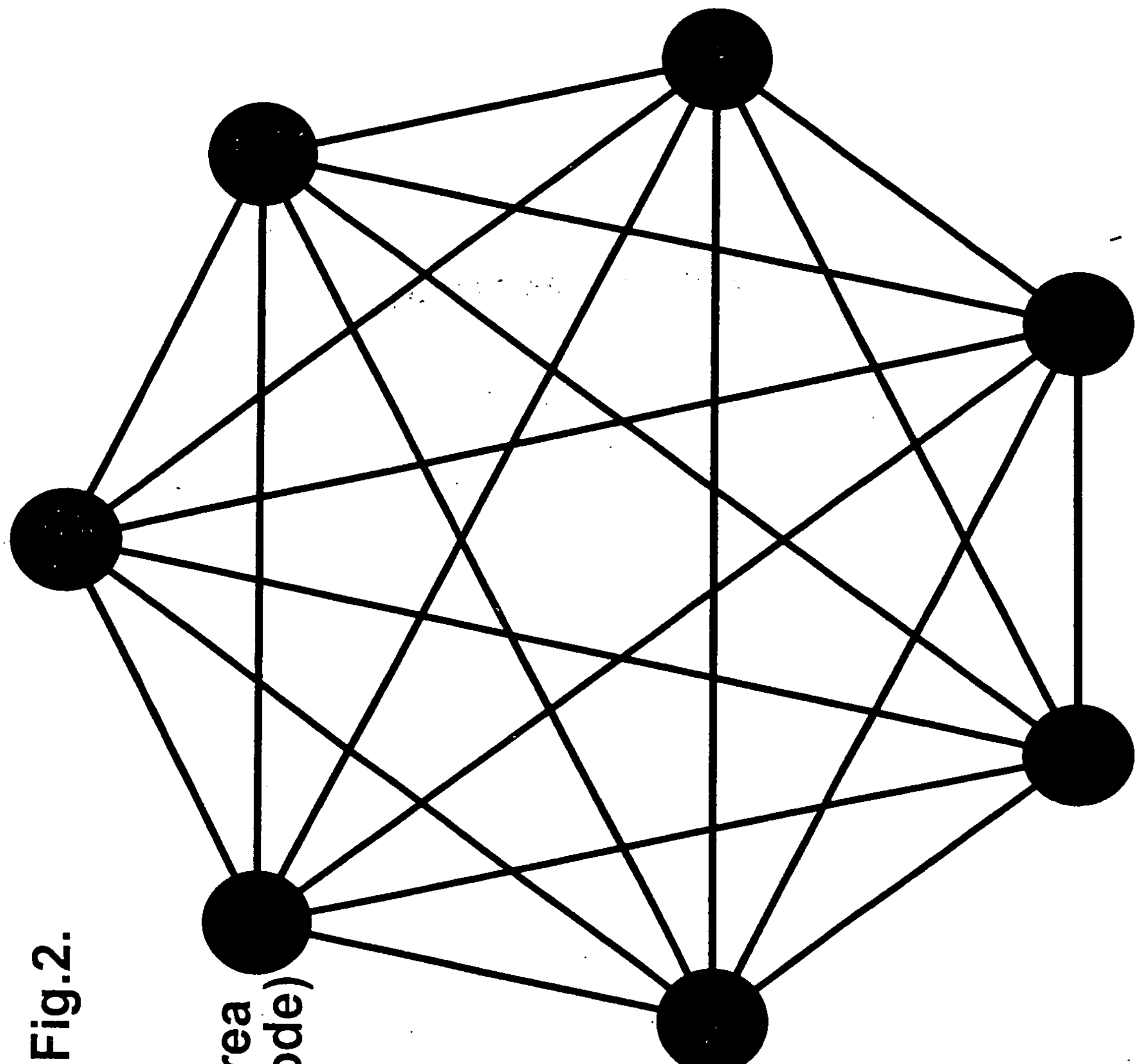

Fig.2.

Fig.3.

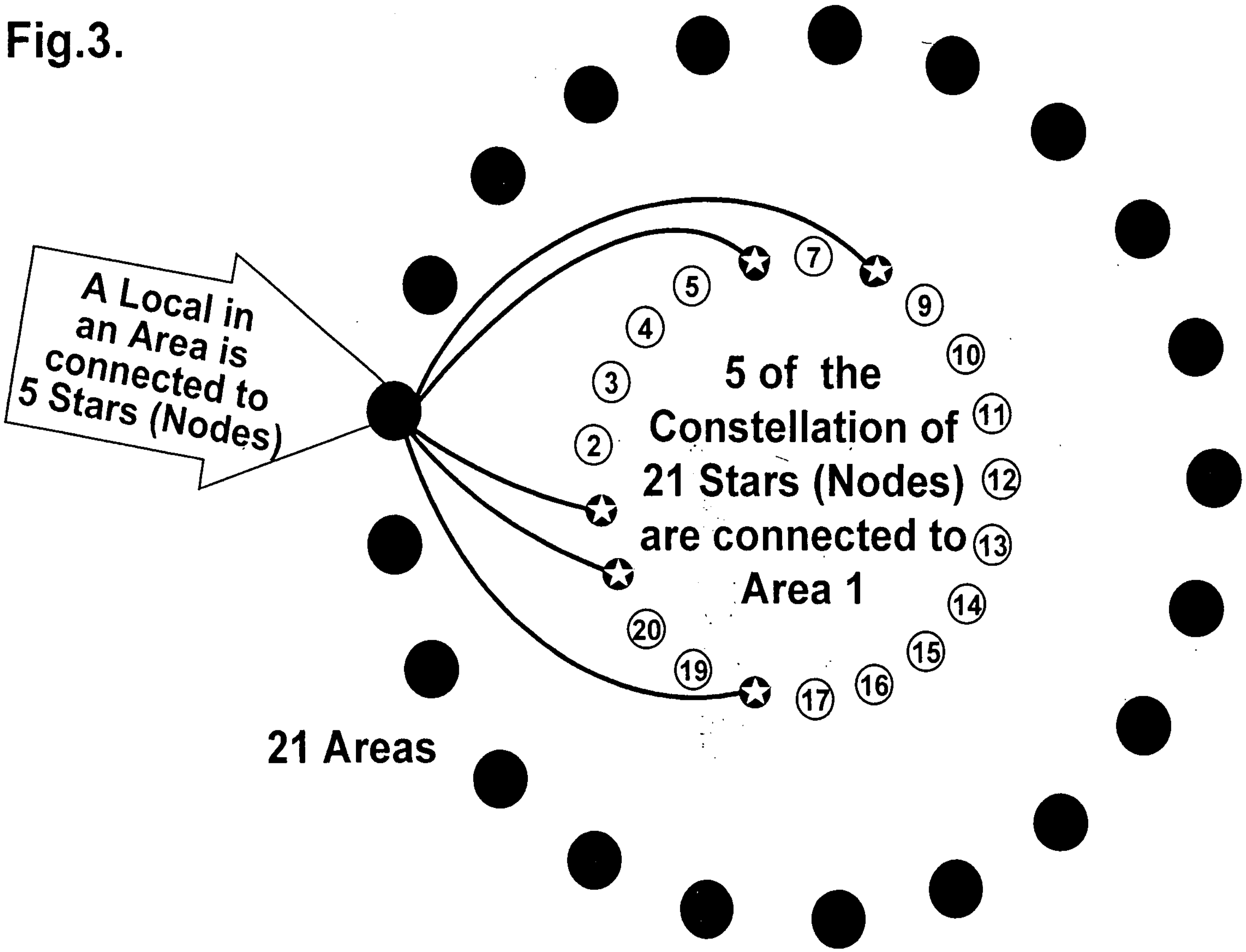
A Local in an Area is connected to 5 Stars (Nodes)
5 of the Constellation of 21 Stars (Nodes) are connected to Area 1
21 Areas
2
3
4
5
7
9
10
11
12
13
14
15
16
17
19
20

Fig.4.

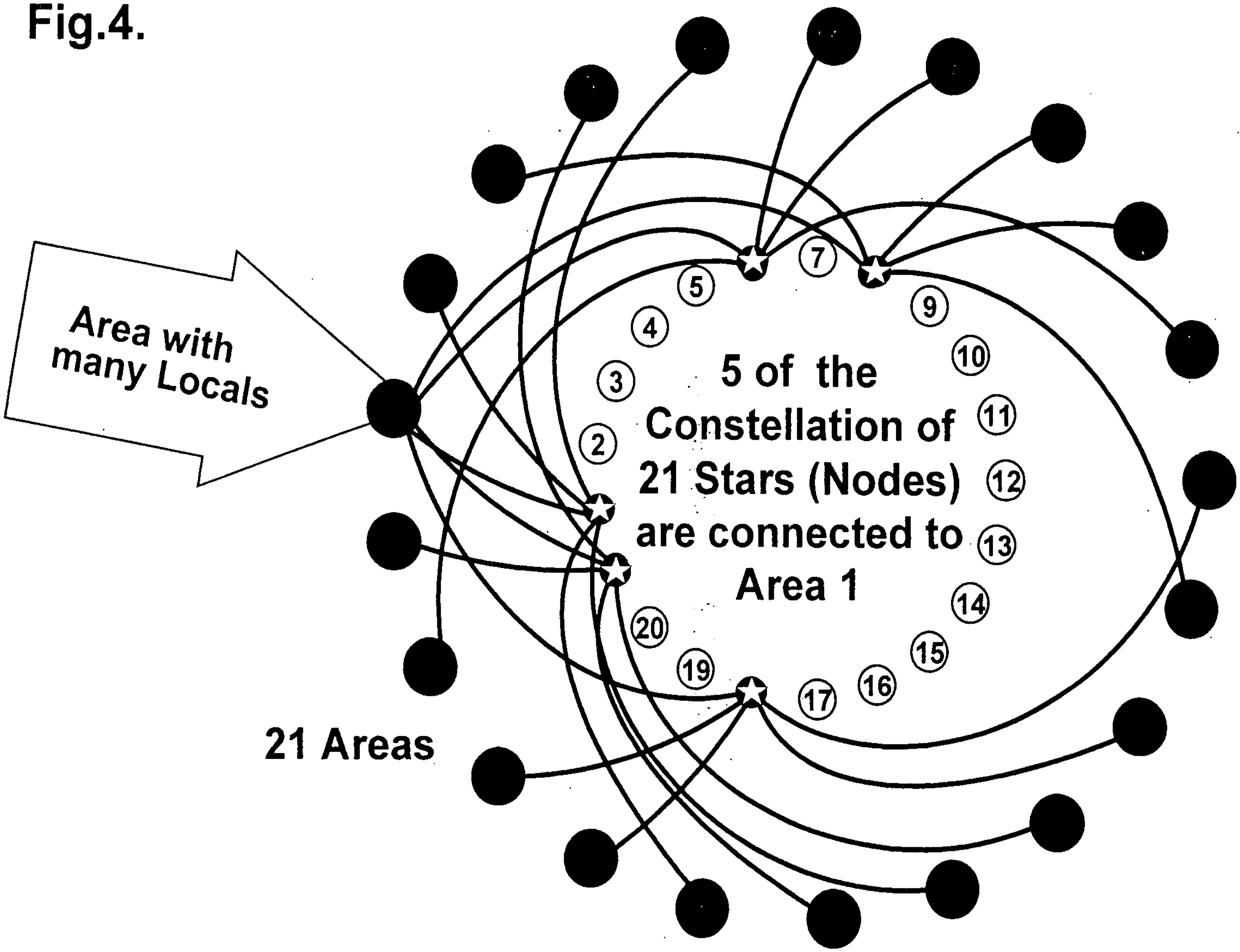
Area with many Locals
5 of the Constellation of 21 Stars (Nodes) are connected to Area 1
2
3
4
5
7
9
10
11
12
13
14
15
16
17
19
20
21 Areas

Fig.5.

Single STARS	AREAS 01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
1	1	1			1										1		1				
2		1	1			1										1		1			
3			1	1			1										1		1		
4				1	1			1										1		1	
5					1	1			1										1		1
6	1					1	1			1										1	
7		1					1	1			1										1
8	1		1					1	1			1									
9		1		1					1	1			1								
10			1		1					1	1			1							
11				1		1					1	1			1						
12					1		1					1	1			1					
13						1		1					1	1			1				
14							1		1					1	1			1			
15								1		1					1	1			1		
16									1		1					1	1			1	
17										1		1					1	1			1
18	1										1		1					1	1		
19		1										1		1					1	1	
20			1										1		1					1	1
21	1			1										1		1					1

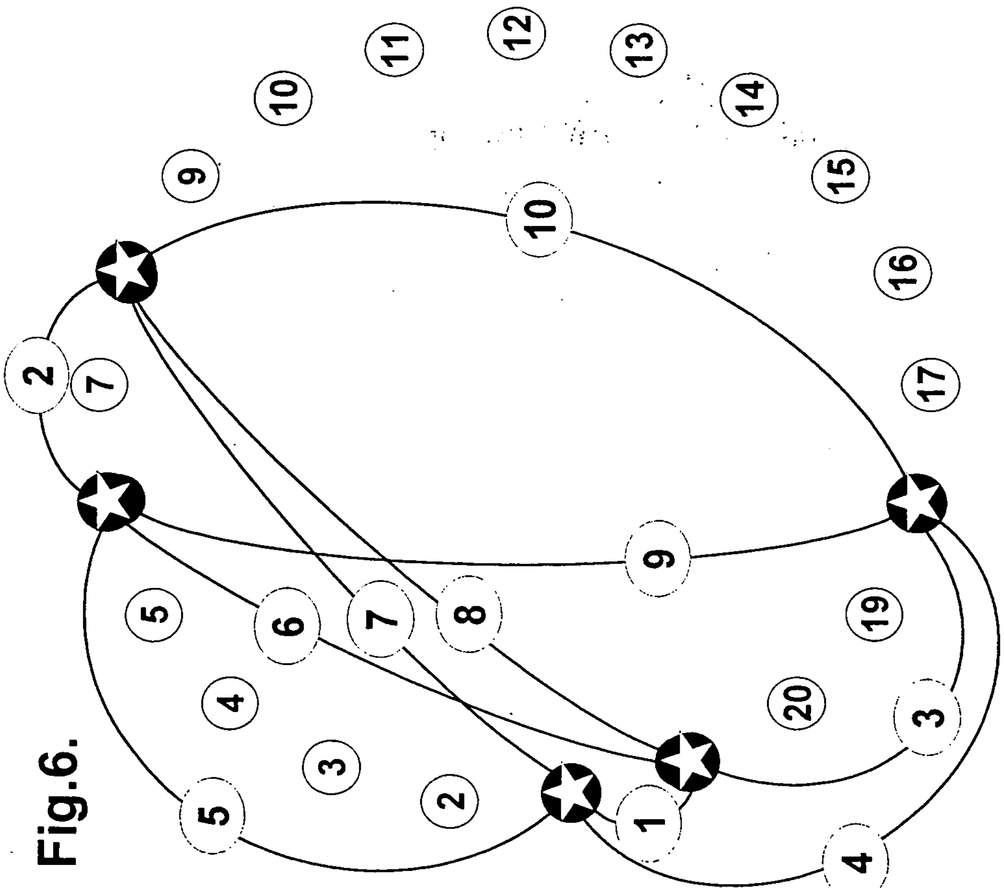

Fig.6.

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Fig.7. AREAS > > > > > > > > > > > > > > > >

Single STARS	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21
1	1					1		1										1			1
2	1	1					1		1										1		
3		1	1					1		1										1	
4			1	1					1		1										1
5	1			1	1					1		1									
6		1			1	1					1		1								
7			1			1	1					1		1							
8				1			1	1					1		1						
9					1			1	1					1		1					
10						1			1	1					1		1				
11							1			1	1					1		1			
12								1			1	1					1		1		
13									1			1	1					1		1	
14										1			1	1					1		1
15	1										1			1	1					1	
16		1										1			1	1					1
17	1		1										1			1	1				
18		1		1										1			1	1			
19			1		1										1			1	1		
20				1		1										1			1	1	
21					1		1										1			1	1

Fig.8. AREAS > > > > > > > > > > > > > > > >

Single STARS	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	
1	1	1	1	1	1																	1
2	1					1	1	1	1													6
3	1									1	1	1	1									8
4	1													1	1	1	1					18
5	1																	1	1	1	1	21
6		1				1				1				1				1				2
7		1					1				1				1				1			7
8		1						1				1				1				1		9
9		1							1				1				1				1	19
10			1			1						1					1		1			5
11			1				1						1			1		1				12
12			1					1		1					1						1	10
13			1						1		1			1						1		4
14				1		1							1		1					1		11
15				1			1					1		1							1	14
16				1				1			1						1	1				15
17				1					1	1						1			1			20
18					1	1					1					1					1	13
19					1		1			1							1			1		3
20					1			1					1	1					1			17
21					1				1			1			1			1				16
	01	02	05	15	17	06	07	10	20	03	08	09	12	18	11	13	19	16	21	04	14	

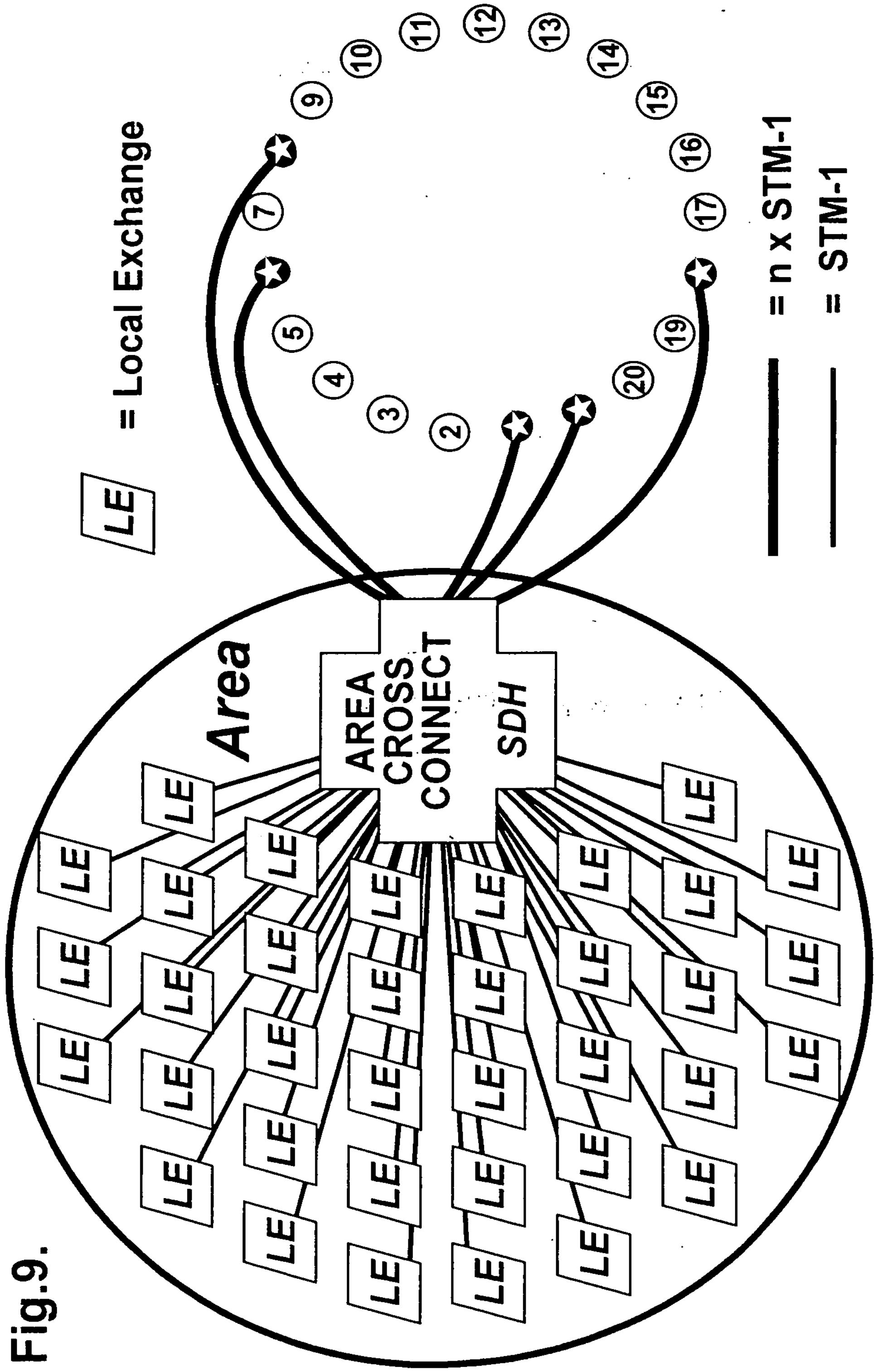

LE = Local Exchange
= n x STM-1
= STM-1
Area
AREA CROSS CONNECT
SDH
LE
2
3
4
5
7
9
10
11
12
13
14
15
16
17
19
20

Fig.9.

Fig.10.

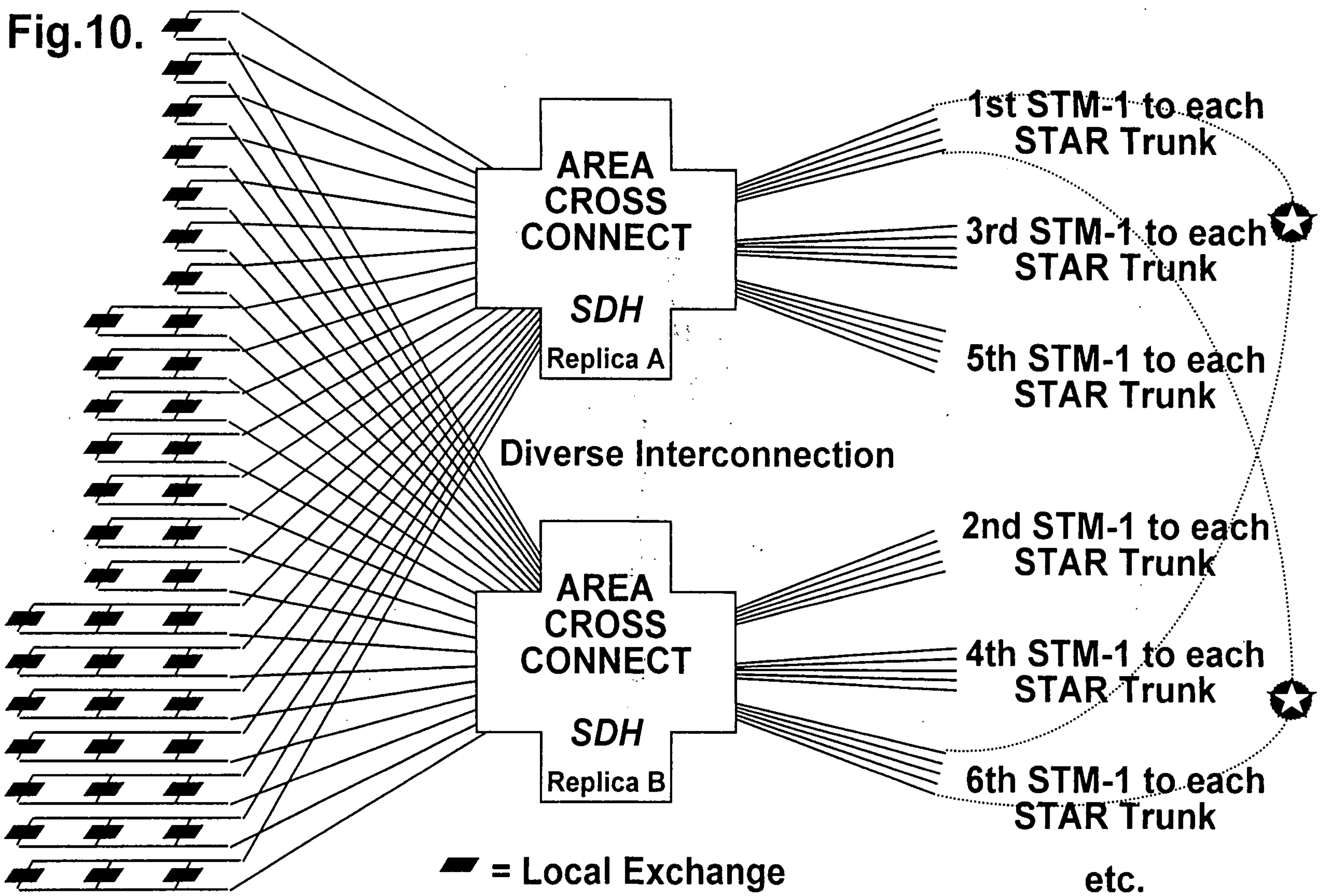

AREA
CROSS
CONNECT
SDH
Replica A
AREA
CROSS
CONNECT
SDH
Replica B
Diverse Interconnection
1st STM-1 to each
STAR Trunk
3rd STM-1 to each
STAR Trunk
5th STM-1 to each
STAR Trunk
2nd STM-1 to each
STAR Trunk
4th STM-1 to each
STAR Trunk
6th STM-1 to each
STAR Trunk
etc.
= Local Exchange

Fig.11.

AREAS | **CHOICES** | **STARS** | **ROUTES** | Fig.

A (A-1) **C** = **S** (R)(R-1)

EXAMPLES OF ROTATIONAL PATTERNS

A (A-1) C = S (R)(R-1)	Fig.	Pattern	
3 (2) 1 = 3 (2)(1)		1 2	
7 (6) 1 = 7 (3)(2)		1 2 4	#7
13 (12) 1 = 13 (4)(3)		1 2 5 7	#4
21 (20) 1 = 21 (5)(4)	5	1 2 5 15 17	
31 (30) 1 = 31 (6)(5)		1 2 9 12 14 18	
57 (56) 1 = 57 (8)(7)		1 2 4 14 33 37 44 53	
73 (72) 1 = 73 (9)(8)		1 2 4 8 16 32 37 55 64	
91 (90) 1 = 91 (10)(9)		1 2 4 10 28 50 57 62 78 82	
133 (132) 1 = 133 (12)(11)		1 2 4 13 21 35 39 82 89 95 105 110	
4 (3) 2 = 4 (3)(2)		1 2 3	#4
7 (6) 2 = 7 (4)(3)	13	1 2 4 7	#7
11 (10) 2 = 11 (5)(4)		1 2 4 7 11	
37 (36) 2 = 37 (9)(8)		1 2 4 8 18 25 26 30 36	
5 (4) 3 = 5 (4)(3)		1 2 3 4	
11 (10) 3 = 11 (6)(5)	14	1 2 3 5 6 8	
15 (14) 3 = 15 (7)(6)		1 2 3 5 6 9 11	#7
6 (5) 4 = 6 (5)(4)		1 2 3 4 5	
15 (14) 4 = 15 (8)(7)		1 2 3 4 6 8 9 12	
19 (18) 4 = 19 (9)(8)	15	1 2 3 4 6 8 13 14 17	
7 (6) 5 = 7 (6)(5)		1 2 3 4 5 6	
19 (18) 5 = 19 (10)(9)	16	1 2 3 4 6 8 13 14 16 17	
23 (22) 5 = 23 (11)(10)		1 2 3 4 6 8 9 12 13 16 18	
8 (7) 6 = 8 (7)(6)		1 2 3 4 5 6 7	
23 (22) 6 = 23 (12)(11)		1 2 3 4 5 7 9 10 13 14 17 19	

EXAMPLES OF MULTI-ROTATIONAL PATTERNS

A (A-1) C = S (R)(R-1)	Fig.					
13 (12) 1 = 26 (3)(2)		1 2 5	1 2 8			
19 (18) 1 = 57 (3)(2)		1 2 5	1 3 10	1 6 12		
25 (24) 1 = 100 (3)(2)		1 2 3	1 5 12	1 6 14	1 7 16	
31 (30) 1 = 155 (3)(2)		1 2 4	1 5 12	1 6 16	1 7 19	1 9 18
37 (36) 1 = 111 (4)(3)		1 2 4 25	1 5 10 16	1 8 18 26		
16 (15) 2 = 80 (3)(2)		1 2 4	1 2 6	1 3 9	1 4 10	1 5 10
19 (18) 2 = 57 (4)(3)		1 2 5 10	1 3 4 10	1 6 8 10		
31 (30) 2 = 93 (5)(4)		1 2 7 9 19	1 2 5 7 16	1 4 12 16 25		
5 (4) 3 = 10 (3)(2)	18	1 2 3	1 2 4			

EXAMPLES OF OTHER ROTATIONAL PATTERNS

A (A-1) C = S (R)(R-1)		
13 (12) 2 = 52 (3)(2)	Stars with 4 routes replaced by four stars with 3 Routes	#4
15 (14) 3 = 105 (3)(2)	Stars with 7 routes replaced by seven stars with 3 Routes	#7

Fig.12.

AREAS	CHOICES		=	STARS	ROUTES	Fig.							
16	(15)	**2**	=	**16**	(6)(5)	22 23							
16	(15)	**1**	=	**20**	(4)(3)	20 21							#4
12	(44)	**3**	=	**44**	(3)(2)	19							
10	(9)	**2**	=	**15**	(4)(3)	24							
8	(7)	**3**	=	**14**	(4)(3)	25							
6	(5)	**2**	=	**10**	(3)(2)	26							
9	(8)	**1**	=	**12**	(3)(2)	27 28	A=RxR	S=R(R+1)	R = odd integer	R= 3	A= 9	S= 12	
25	(24)	**1**	=	**30**	(5)(4)	29	A=RxR	S=R(R+1)	R = odd integer	R= 5	A= 25	S= 30	
49	(48)	**1**	=	**56**	(7)(6)	30	A=RxR	S=R(R+1)	R = odd integer	R= 7	A= 49	S= 56	#7
81	(80)	**1**	=	**90**	(9)(8)		A=RxR	S=R(R+1)	R = odd integer	R= 9	A= 81	S= 90	
121	(120)	**1**	=	**132**	(11)(10)		A=RxR	S=R(R+1)	R = odd integer	R= 11	A=121	S=132	
169	(168)	**1**	=	**182**	(13)(12)		A=RxR	S=R(R+1)	R = odd integer	R= 13	A=169	S=182	
225	(224)	**1**	=	**240**	(15)(14)		A=RxR	S=R(R+1)	R = odd integer	R= 15	A=225	S=240	
289	(288)	**1**	=	**306**	(17)(16)		A=RxR	S=R(R+1)	R = odd integer	R= 17	A=289	S=306	
361	(360)	**1**	=	**380**	(19)(18)		A=RxR	S=R(R+1)	R = odd integer	R=19	A=361	S=380	
			etc.										
15	(14)	**1**	=	**35**	(3)(2)	31	Odd number of Groups: each Group = 3 Areas: R=3						
21	(20)	**1**	=	**70**	(3)(2)	32	Odd number of Groups: each Group = 3 Areas: R=3						
27	(26)	**1**	=	**117**	(3)(2)	33	Odd number of Groups: each Group = 3 Areas: R=3						
33	(32)	**1**	=	**176**	(3)(2)		Odd number of Groups: each Group = 3 Areas: R=3						
39	(38)	**1**	=	**247**	(3)(2)		Odd number of Groups: each Group = 3 Areas: R=3						
45	(44)	**1**	=	**330**	(3)(2)		Odd number of Groups: each Group = 3 Areas: R=3						
51	(50)	**1**	=	**425**	(3)(2)		Odd number of Groups: each Group = 3 Areas: R=3						
			etc.										
16	(15)	**2**	=	**80**	(3)(2)		Stars with 4 routes replaced by four stars with 3 Routes						#4
49	(48)	**1**	=	**392**	(3)(2)		Stars with 7 routes replaced by seven stars with 3 Routes						#7
49	(48)	**2**	=	**392**	(4)(3)		Stars with 7 routes replaced by seven stars with 4 Routes						#7

Fig.13. A R E A S

Twin

STARS	01	02	03	04	05	06	07
1	1	1		1			1
2	1	1	1		1		
3		1	1	1		1	
4			1	1	1		1
5	1			1	1	1	
6		1			1	1	1
7	1		1			1	1

Fig.14. A R E A S > > > > > >

Triple

STARS	01	02	03	04	05	06	07	08	09	10	11
1	1	1	1		1	1		1			
2		1	1	1		1	1		1		
3			1	1	1		1	1		1	
4				1	1	1		1	1		1
5	1				1	1	1		1	1	
6		1				1	1	1		1	1
7	1		1				1	1	1		1
8	1	1		1				1	1	1	
9		1	1		1				1	1	1
10	1		1	1		1				1	1
11	1	1		1	1		1				1

Fig.15. A R E A S > > > > > > > > > > > > >

Quad

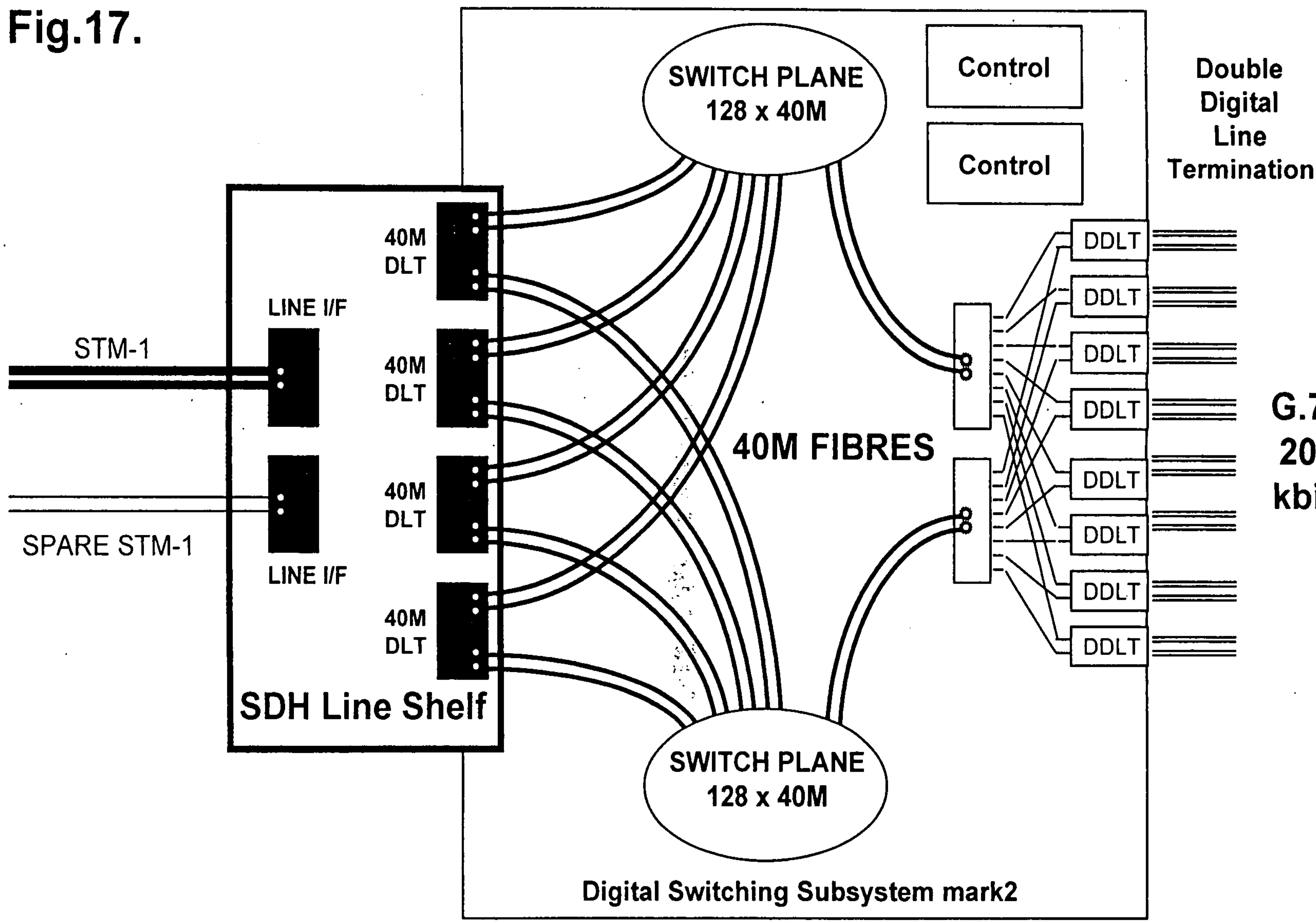
STARS	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1		1		1					1	1			1		
2		1	1	1	1		1		1					1	1			1	
3			1	1	1	1		1		1					1	1			1
4	1			1	1	1	1		1		1					1	1		
5		1			1	1	1	1		1		1					1	1	
6			1			1	1	1	1		1		1					1	1
7	1			1			1	1	1	1		1		1					1
8	1	1			1			1	1	1	1		1		1				
9		1	1			1			1	1	1	1		1		1			
10			1	1			1			1	1	1	1		1		1		
11				1	1			1			1	1	1	1		1		1	
12					1	1			1			1	1	1	1		1		1
13	1					1	1			1			1	1	1	1		1	
14		1					1	1			1			1	1	1	1		1
15	1		1					1	1			1			1	1	1	1	
16		1		1					1	1			1			1	1	1	1
17	1		1		1					1	1			1			1	1	1
18	1	1		1		1					1	1			1			1	1
19	1	1	1		1		1					1	1			1			1

Fig.16. A R E A S > > > > > > > > > > > > >

Quin

STARS	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1	1	1	1	1		1		1					1	1		1	1		
2		1	1	1	1		1		1					1	1		1	1	
3			1	1	1	1		1		1					1	1		1	1
4	1			1	1	1	1		1		1					1	1		1
5	1	1			1	1	1	1		1		1					1	1	
6		1	1			1	1	1	1		1		1					1	1
7	1		1	1			1	1	1	1		1		1					1
8	1	1		1	1			1	1	1	1		1		1				
9		1	1		1	1			1	1	1	1		1		1			
10			1	1		1	1			1	1	1	1		1		1		
11				1	1		1	1			1	1	1	1		1		1	
12					1	1		1	1			1	1	1	1		1		1
13	1					1	1		1	1			1	1	1	1		1	
14		1					1	1		1	1			1	1	1	1		1
15	1		1					1	1		1	1			1	1	1	1	
16		1		1					1	1		1	1			1	1	1	1
17	1		1		1					1	1		1	1			1	1	1
18	1	1		1		1					1	1		1	1			1	1
19	1	1	1		1		1					1	1		1	1			1

Fig.17.



STM-1
SPARE STM-1
LINE I/F
LINE I/F
40M DLT
40M DLT
40M DLT
40M DLT
SDH Line Shelf
SWITCH PLANE 128 x 40M
SWITCH PLANE 128 x 40M
Control
Control
40M FIBRES
DDLT
DDLT
DDLT
DDLT
DDLT
DDLT
DDLT
DDLT
Double Digital Line Termination
G.703 2048 kbit/s
Digital Switching Subsystem mark2

Fig.18. Triple

STARS	AREAS 01	02	03	04	05
1	1	1	1		
2		1	1	1	
3			1	1	1
4	1			1	1
5	1	1			1
6	1	1		1	
7		1	1		1
8	1		1	1	
9		1		1	1
10	1		1		1

Fig.19. Twin

STARS	AREAS 01	02	03	04	05	06	> 07	> 08	> 09	> 10	> 11	> 12
1	1	1										1
2	1	1	1									
3	1		1	1								
4	1			1	1							
5	1				1	1						
6	1					1	1					
7	1						1	1				
8	1							1	1			
9	1								1	1		
10	1									1	1	
11	1										1	1
12		1			1							1
13		1	1			1						
14			1	1			1					
15				1	1			1				
16					1	1			1			
17						1	1			1		
18							1	1			1	
19								1	1			1
20		1							1	1		
21			1							1	1	
22				1							1	1
23		1		1			1					
24			1		1			1				
25				1		1			1			
26					1		1			1		
27						1		1			1	
28							1		1			1
29		1						1		1		
30			1						1		1	
31				1						1		1
32		1			1						1	
33			1			1						1
34		1		1				1				
35			1		1				1			
36				1		1				1		
37					1		1				1	
38						1		1				1
39		1					1		1			
40			1					1		1		
41				1					1		1	
42					1					1		1
43		1				1					1	
44			1				1					1

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Fig.20.	A	R	E	A	S		>	>	>	>	>	>	>	>	>	>
Twin	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STARS	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
1	1	1		1			1				1				1	
2	1	1	1					1				1				1
3		1	1	1	1				1				1			
4	1		1	1		1				1				1		
5			1		1	1		1			1				1	
6				1	1	1	1					1				1
7	1					1	1	1	1				1			
8		1			1		1	1		1				1		
9			1				1		1	1		1			1	
10				1				1	1	1	1					1
11	1				1					1	1	1	1			
12		1				1			1		1	1		1		
13			1				1				1		1	1		1
14				1				1				1	1	1	1	
15	1				1				1					1	1	1
16		1				1				1			1		1	1

Fig.21.	A	R	E	A	S		>	>	>	>	>	>	>	>	>	>
Twin	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STARS	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
1		1	1	1	1				1				1			
2	1		1	1		1				1				1		
3	1	1		1			1				1				1	
4	1	1	1					1				1				1
5	1					1	1	1	1				1			
6		1			1		1	1		1				1		
7			1		1	1		1			1				1	
8				1	1	1	1					1				1
9	1				1					1	1	1	1			
10		1				1			1		1	1		1		
11			1				1		1	1		1			1	
12				1				1	1	1	1					1
13	1				1				1					1	1	1
14		1				1				1			1		1	1
15			1				1				1		1	1		1
16				1				1				1	1	1	1	

Fig.22.	A	R	E	A	S		>	>	>	>	>	>	>	>	>	>
Single	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STARS	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
1	1						1				1		1			
2		1				1			1				1			
3			1		1				1						1	
4				1				1			1				1	
5				1	1							1	1			
6				1		1				1						1
7			1				1					1				1
8	1							1	1							1
9				1			1		1					1		
10		1					1			1					1	
11			1			1					1			1		
12		1						1				1		1		
13			1					1		1			1			
14	1				1					1				1		
15	1					1						1			1	
16		1			1						1					1
17	1	1	1	1												
18					1	1	1	1								
19									1	1	1	1				
20													1	1	1	1

Fig.23.	A	R	E	A	S		>	>	>	>	>	>	>	>	>	>
Single	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
STARS	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6
1	1	1						1		1						
2		1	1			1			1							
3			1	1			1			1						
4				1	1	1		1								
5	1				1		1		1							
6						1	1						1		1	
7							1	1			1			1		
8								1	1			1			1	
9									1	1	1		1			
10						1				1		1		1		
11			1		1						1	1				
12	1			1								1	1			
13		1			1								1	1		
14	1		1											1	1	
15		1		1							1				1	
16	1					1					1					1
17		1					1					1				1
18			1					1					1			1
19				1					1					1		1
20					1					1					1	1

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Fig.24. A R E A S > > > >

Twin STARS	01	02	03	04	05	06	07	08	09	10
1	1		1	1		1				
2	1	1		1	1					
3		1	1		1	1				
4				1		1	1		1	
5				1	1		1	1		
6					1	1		1	1	
7	1		1				1		1	
8	1	1					1	1		
9		1	1					1	1	
10	1				1				1	1
11		1				1	1			1
12			1	1				1		1
13	1					1		1		1
14		1		1					1	1
15			1		1		1			1

Fig.25. A R E A S > >

Triple STARS	01	02	03	04	05	06	07	08
1	1	1			1	1		
2		1	1			1	1	
3			1	1			1	1
4	1			1	1			1
5	1		1		1		1	
6		1		1		1		1
7	1	1					1	1
8		1	1		1			1
9			1	1	1	1		
10	1			1		1	1	
11	1		1			1		1
12		1		1	1		1	
13	1	1	1	1				
14					1	1	1	1

Fig.26. A R E A S

Twin STARS	01	02	03	04	05	06
1	1	1				1
2	1	1	1			
3	1		1	1		
4	1			1	1	
5	1				1	1
6		1		1		1
7		1	1		1	
8			1	1		1
9		1		1	1	
10			1		1	1

Fig.27. A R E A S > > >

Single STARS	01	02	03	04	05	06	07	08	09
1	1	1	1						
2				1	1	1			
3							1	1	1
4	1			1				1	
5	1				1		1		
6		1		1			1		
7		1			1				1
8		1				1		1	
9			1		1			1	
10			1			1	1		
11			1	1					1
12	1					1			1

Fig.28. A R E A S > > >

Single STARS	01	02	03	04	05	06	07	08	09
1	1			1			1		
2		1			1			1	
3			1			1			1
4			1	1				1	
5	1				1				1
6		1				1	1		
7			1		1		1		
8	1					1		1	
9		1		1					1
10	1	1	1						
11				1	1	1			
12							1	1	1

Fig.29.

AREAS >

Single STARS	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	1					1					1					1					1				
2		1					1					1					1					1			
3			1					1					1					1					1		
4				1					1					1					1					1	
5					1					1					1					1					1
6					1	1						1						1						1	
7	1						1						1						1						1
8		1						1						1						1	1				
9			1						1						1	1						1			
10				1						1	1						1						1		
11		1							1		1							1							1
12			1							1		1							1		1				
13				1		1							1							1		1			
14					1		1							1		1							1		
15	1							1							1		1							1	
16		1								1			1			1								1	
17			1			1								1			1								1
18				1			1								1			1			1				
19					1			1			1								1			1			
20	1								1			1								1			1		
21					1				1				1				1				1				
22	1									1				1				1				1			
23		1				1									1				1				1		
24			1				1				1									1				1	
25				1				1				1				1									1
26	1	1	1	1	1																				
27						1	1	1	1	1															
28											1	1	1	1	1										
29																1	1	1	1	1					
30																					1	1	1	1	1

Fig.30. Single STARS \ AREAS >	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
1	1							1							1							1							1							1							1						
2		1							1							1							1							1							1							1					
3			1							1							1							1							1							1							1				
4				1							1							1							1							1							1							1			
5					1							1							1							1							1							1							1		
6						1							1							1							1							1							1							1	
7							1							1							1							1							1							1							1
8							1	1								1								1								1								1								1	
9	1								1								1								1								1								1								1
10		1								1								1								1								1								1	1						
11			1								1								1								1								1	1								1					
12				1								1								1								1	1								1								1				
13					1								1								1	1								1								1								1			
14						1								1	1								1								1								1								1		
15				1										1		1									1									1									1		1					
16					1										1		1									1									1		1								1				
17						1		1										1									1									1		1								1			
18							1		1										1									1		1									1								1		
19	1									1									1									1		1									1								1	
20		1									1									1		1									1									1								1
21			1									1									1		1									1									1	1						
22						1			1										1			1										1										1			1				
23							1			1										1			1										1			1									1			
24	1										1										1			1										1			1									1		
25		1										1			1										1										1			1									1	
26			1										1			1										1			1										1									1
27				1										1			1										1			1										1		1						
28					1			1										1										1			1										1		1					
29						1				1											1				1				1											1				1					
30							1				1				1											1				1											1				1				
31	1											1				1											1				1											1				1			
32		1											1				1											1				1				1											1		
33			1											1				1				1											1				1											1	
34				1				1											1				1											1				1											1
35					1				1											1				1											1				1				1						
36				1					1												1					1					1					1												1	
37					1					1					1												1					1					1												1
38						1					1					1												1					1					1					1						
39							1					1					1					1												1					1					1					
40	1												1					1					1												1					1					1				
41		1												1					1					1					1												1					1			
42			1					1												1					1					1												1					1		
43							1						1						1						1						1						1						1						
44	1													1						1						1						1						1						1					
45		1						1													1						1						1						1						1				
46			1						1						1													1						1						1						1			
47				1						1						1						1													1						1						1		
48					1						1						1						1						1													1						1	
49						1						1						1						1						1						1													1
50	1	1	1	1	1	1	1																																										
51								1	1	1	1	1	1	1																																			
52															1	1	1	1	1	1	1																												
53																						1	1	1	1	1	1	1																					
54																													1	1	1	1	1	1	1														
55																																				1	1	1	1	1	1	1							
56																																											1	1	1	1	1	1	1

Fig.31.

Single

STARS	AREAS 01	> 02	> 03	> 04	> 05	> 06	> 07	> 08	> 09	> 10	> 11	> 12	> 13	> 14	> 15	
1	1	1	1													
2				1	1	1										
3							1	1	1							
4										1	1	1				
5													1	1	1	
6	1			1							1					1
7				1			1							1		14
8		1					1			1						2
9					1					1			1			5
10	1							1					1			13
11	1				1		1									7
12				1				1		1						8
13							1				1		1			11
14	1									1				1		10
15		1		1									1			4
16		1			1							1				12
17					1			1							1	15
18			1					1			1					3
19						1					1			1		6
20		1							1					1		9
21		1				1		1								
22					1				1		1					
23								1				1		1		
24		1									1				1	
25			1		1									1		
26			1			1				1						
27						1			1				1			
28	1								1			1				
29				1								1			1	
30			1				1								1	
31			1	1					1							
32						1	1					1				
33									1	1					1	
34			1									1	1			
35	1					1									1	

STARS	AREAS 01	> 02	> 03	> 04	> 05	> 06	> 07	> 08	> 09	> 10	> 11	> 12	> 13	> 14	> 15
1	1	2	3												
2				1	2	3									
3							1	2	3						
4										1	2	3			
5													1	2	3
6	1			1							2				
7				1			1							2	
8		2					1			1					
9					2					1			1		
10	1							2					1		
11	1				2		1								
12				1				2		1					
13							1				2		1		
14	1									1				2	
15		2		1									1		
16		2			2							3			
17					2			2							3
18			3					2			2				
19						3					2			2	
20		2							3					2	
21		2				3		2							
22					2				3		2				
23								2				3		2	
24		2									2				3
25			3		2									2	
26			3			3				1					
27						3			3				1		
28	1								3			3			
29				1								3			3
30			3				1								3
31			3	1					3						
32						3	1					3			
33									3	1					3
34			3									3	1		
35	1					3									3

STARS	AREAS 15				
	3	3	3	3	3
1	A				
2		A			
3			A		
4				A	
5					A
6	1	1		2	
7		1	1		2
8	2		1	1	
9		2		1	1
10	1		2		1
11	1	2	1		
12		1	2	1	
13			1	2	1
14	1			1	2
15	2	1			1
16	2	2		3	
17		2	2		3
18	3		2	2	
19		3		2	2
20	2		3		2
21	2	3	2		
22		2	3	2	
23			2	3	2
24		2		2	3
25		3	2		2
26	3	3		1	
27		3	3		1
28	1		3	3	
29		1		3	3
30	3		1		3
31	3	1	3		
32		3	1	3	
33			3	1	3
34	3			3	1
35	1	3			3

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Fig.32.

Single STARS	AREAS 21						
	3	3	3	3	3	3	3
1	A						
2		A					
3			A				
4				A			
5					A		
6						A	
7							A
8	1	1			2		
9		1	1			2	
10			1	1			2
11	2			1	1		
12		2			1	1	
13			2			1	1
14	1			2			1
15	1	2	1				
16		1	2	1			
17			1	2	1		
18				1	2	1	
19					1	2	1
20	1					1	2
21	2	1					1
22	1			1		2	
23		1			1		2
24	2		1			1	
25		2		1			1
26	1		2		1		
27		1		2		1	
28			1		2		1

	AREAS 21						
	3	3	3	3	3	3	3
29	2	2			3		
30		2	2			3	
31			2	2			3
32	3			2	2		
33		3			2	2	
34			3			2	2
35	2			3			2
36	2	3	2				
37		2	3	2			
38			2	3	2		
39				2	3	2	
40					2	3	2
41	2					2	3
42	3	2					2
43	2			2		3	
44		2			2		3
45	3		2			2	
46		3		2			2
47	2		3		2		
48		2		3		2	
49			2		3		2

	AREAS 21						
	3	3	3	3	3	3	3
50	3	3			1		
51		3	3			1	
52			3	3			1
53	1			3	3		
54		1			3	3	
55			1			3	3
56	3			1			3
57	3	1	3				
58		3	1	3			
59			3	1	3		
60				3	1	3	
61					3	1	3
62	3					3	1
63	1	3					3
64	3			3		1	
65		3			3		1
66	1		3			3	
67		1		3			3
68	3		1		3		
69		3		1		3	
70			3		1		3

Fig.33.

Fig.33.	AREAS								
Single	27								
STARS	3	3	3	3	3	3	3	3	3
1	A								
2		A							
3			A						
4				A					
5					A				
6						A			
7							A		
8								A	
9									A
10	1	1				2			
11		1	1				2		
12			1	1				2	
13				1	1				2
14	2				1	1			
15		2				1	1		
16			2				1	1	
17				2				1	1
18	1				2				1
19	1	2	1						
20		1	2	1					
21			1	2	1				
22				1	2	1			
23					1	2	1		
24						1	2	1	
25							1	2	1
26	1							1	2
27	2	1							1
28	1			1			2		
29		1			1			2	
30			1			1			2
31	2			1			1		
32		2			1			1	
33			2			1			1
34	1			2			1		
35		1			2			1	
36			1			2			1
37	1		2		1				
38		1		2		1			
39			1		2		1		
40				1		2		1	
41					1		2		1
42	1					1		2	
43		1					1		2
44	2		1					1	
45		2		1					1

	AREAS								
	27								
	3	3	3	3	3	3	3	3	3
46	2	2				3			
47		2	2				3		
48			2	2				3	
49				2	2				3
50	3				2	2			
51		3				2	2		
52			3				2	2	
53				3				2	2
54	2				3				2
55	2	3	2						
56		2	3	2					
57			2	3	2				
58				2	3	2			
59					2	3	2		
60						2	3	2	
61							2	3	2
62	2							2	3
63	3	2							2
64	2			2			3		
65		2			2			3	
66			2			2			3
67	3			2			2		
68		3			2			2	
69			3			2			2
70	2			3			2		
71		2			3			2	
72			2			3			2
73	2		3		2				
74		2		3		2			
75			2		3		2		
76				2		3		2	
77					2		3		2
78	2					2		3	
79		2					2		3
80	3		2					2	
81		3		2					2

	AREAS								
	27								
	3	3	3	3	3	3	3	3	3
82	3	3				1			
83		3	3				1		
84			3	3				1	
85				3	3				1
86	1				3	3			
87		1				3	3		
88			1				3	3	
89				1				3	3
90	3				1				3
91	3	1	3						
92		3	1	3					
93			3	1	3				
94				3	1	3			
95					3	1	3		
96						3	1	3	
97							3	1	3
98	3							3	1
99	1	3							3
100	3			3			1		
101		3			3			1	
102			3			3			1
103	1			3			3		
104		1			3			3	
105			1			3			3
106	3			1			3		
107		3			1			3	
108			3			1			3
109	3		1		3				
110		3		1		3			
111			3		1		3		
112				3		1		3	
113					3		1		3
114	3					3		1	
115		3					3		1
116	1		3					3	
117		1		3					3

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